RECORDS OF CHEMICAL SCIENCES

Assessment of Ecological and Environmental Pollution of Kanye Dam, Rimin Gado Local Government Area, Kano State

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https://doi.org/10.33003/frscs_2024_0303/02

Accepted: 23th July, 2024
Published: 11th August, 2024

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FRsCS Vol.3 No. 3 (2024)
Official Journal of Dept. of Chemistry, Federal University of Dutsin-Ma, Katsina State.
http://rudmafudma.com

ISSN (Online): 2705-2362
ISSN (Print): 2705-2354

Abstract

This study examined the distribution, composition, and relative abundance of phytoplankton and zooplankton in Kanye Dam from March to August, 2024 using standard methods for water physicochemical and heavy metals as well as Planktons diversity with a focus on pollution impacts. The investigation identified three main classes of phytoplankton: Bacillariophyceae (42.55%), Cyanophyceae (34%), and Chlorophyceae (16.17%). Significant variations ($P>0.01$) were observed in phytoplankton distribution across different months and sampling stations, with higher numbers recorded during the early rainy season and lower numbers during the dry season. Among the Cyanophyceae, three species—*Phacus sp., Oscillatoria sp.,* and Euglena sp. present, with Euglena sp. being the most prevalent throughout the year. The Bacillariophyceae included seven species, with *Tabellaria sp.* showing the highest occurrence across all stations. In the *Chlorophyceae, Microcystis sp.* and *Ulothrix sp.* were most frequently observed. For zooplankton, Protozoa, including *Tracheolomonas sp., Plectus sp., Paramecium sp., Euglena sp., Amoeba sp., Haplotaxis sp., Vorticella sp., and Anisonema sp*., were also present, with Amoeba sp. being the most abundant. Annelida were represented by a single species known as Diplogasteroides, with a total of 15 representatives. The distribution and composition of both phytoplankton and zooplankton in Kanye Dam were influenced by ecological and environmental changes which were found to be within the permissible limit for aquatic life, with higher plankton numbers observed during the months of the rainy season compared to those of dry season. The water body experiences less pollution the other water bodies within the area which makes it safe for these organisms to thrive well.

Keywords: Ecology, Pollution, Zooplankton and Phytoplanktons, Heavy metals

Introduction

Water is a primary natural resource and its availability has played a vital role in the evolution of human settlements in the course of the development of human societies. In the last two decades, there has been a growing necessity for conservation of our resources, especially water. At the same time, growing populations, progressive industrialization and intensification of agriculture led to increased pollution of the surface waters, which induces ecological imbalance, is deleterious for the sustained development of fisheries resources and has necessitated the suspension of the beneficial uses of these water in some places (Chapman, 2008). Kano State has the largest concentration of manmade lakes in Nigeria with about 26 reservoirs in the state including Kanye, Watari, Tiga, Challawa-Goje, Bagauda, Watari and Bagwai dams which range in size from a few hectares to up to 17,000ha. Over the years, climatic changes and increased human activities such as farming activities both rain-fed and irrigation with the catchments basin of most of the reservoirs have resulted in gradual silting up, nutrient building up and invasion of aquatic plants. In addition, Accelerated population growth, industrialization and poor waste management and environmental pollution control pose a grave challenge to food and environmental safety in many developing countries including Nigeria (Abdullahi and Mohammed, 2020; Abdullahi et al., 2021).

Breach of environmental regulations and failure of environmental regulatory agencies to actively enforce environmental protection laws contributed immensely to the poor quality of surface water in Nigeria (Ighalo and Adeniyi, 2020, Abdullahi et al., 2021). Rodrigues-Filho et al. (2023) state that water bodies are essential for maintaining various ecological functions and aquatic life, including fish species. However, the aquatic life and human populations that depend on these resources are seriously threatened by pollution (Farhan et al., 2023). In aquatic ecosystems, these elements accumulate in fish and shellfish, posing a threat to aquatic life and human consumers. There has been increasing concern about the rate at which inland waters are polluted through run-offs into streams and lakes therefore leading to eutrophication which affects the specific composition of Zooplankton through physical and chemical alternations of the environment as well as changing the composition of these water bodies (Chapman, 2008). In light of the above, therefore, there is an apparent need to study the ecological aspects of the Kanye Dam as it is a source of potable and irrigation water for a large population in the area. Proper knowledge of the ecology of the dam will provide information on the productivity of the dam so that communities can properly explore its resourcefulness.

Materials and Methods

Study area

Kanye Dam is located in the Sudan savannah zone of Northern Nigeria on latitude $11^0$97'N and longitude 8^0.1'E with two distinct seasons (wet and dry). The rainy season period lasts from May to October while the dry season lasts from November to April. The Kanye Dam is approximately 50 km away from Kano along the Kano-Gwarzo road in Kabo Local Government Area of Kano State and about 11.25 km from Kabo town. It has an area of 11.31 km^2. The dam was impounded in 1969 and commissioned in 1970. It has two major sources that are river Guzu-Guzu and river Kanyan Maja

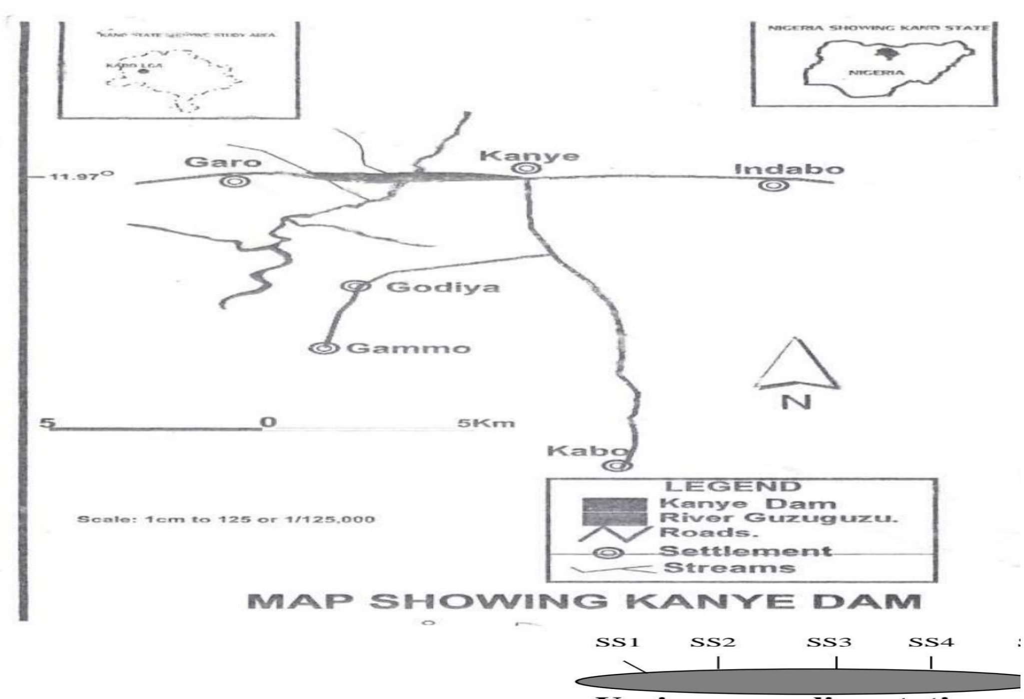

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Figure 1: Map of Kanye Dam and Sampling Stations

Sampling methods

From each sampling station, water samples were collected each month starting from March to August 2024. The sampling was accomplished between 8:00 am to 1:00 pm and 1.5 litres of plastic bottles was used in collecting water samples and transported to the laboratory for physicochemical analysis, zooplankton, and phytoplankton identification. The physicochemical parameters evaluated were pH, alkalinity conductivity, transparency, nitrate-nitrogen, and phosphate-phosphorus as described by APHA (2005)

Heavy Metal Analysis

Sample digestion

Digestion of samples for analysis of heavy metals was carried out before the sample analysis. 100 ml of sample was introduced into 250 cm^3 beaker, anti-bumping granules and 1.5 cm^3 beaker, anti-bumping granules and 1.5 cm_3 of conc. HNO_3 was added. The samples were beneath the water surface and towed for a distance of about 1 meter.

The samples were transferred to a small plastic bottle and preserved in 4% neutral formalin. The samples from each station were taken to the laboratory for identification.

For quantitative estimation, 1 ml of the 50 ml water collected was counted under the microscope, and the number of algal cells expressed per liter.

The relative abundance of various taxa was calculated using the formula

$$N = \frac{a}{bn} .$$

N= Estimated number of species per sample

n = Number of species in sub-sample

a = Volume of water sample (ml) (50 ml)

b = Volume (ml) of sub-sample (1 ml)

then heated until they evaporated to about 20 cm^3. It was then cooled and diluted to 100 cm^3 and kept for analysis.

Manganese (Mn). Iron (Fe), Copper (Cu), Zinc (Zn), Hach (2010) spectrophotometer. The instrument was set to 620 nm wavelength. 10ml of the blank was placed in the sample cell and its concentration was determined at this wavelength. The instrument was then zeroed at the blank sample concentration obtained. Ten (10ml) of digested samples were introduced into the sample cell and put into the machine. The concentration of iron in the samples was determined and recorded.

Biological Identification Methods

Phytoplankton sampling

Phytoplankton examination was done using a plankton net with a conical bag (Net mesh size of 0.01 mm) 25 cm long, attached to a 50 ml bottle, and with an opening of about 20 cm diameter. At each station, the net was sunk just The abundance of taxa in each sample was calculated using the formula

$$D = \frac{N}{V}$$

D = Abundance of species (individuals per liter)

N= Estimated number of species per sample

V = Volume (Liters) of water originally filtered as described by (Hassan *et al.*, 2013)

Identification was carried out by the use of keys and identification guides as described by APHA (2005) and Lind (1986)

Zooplankton and Phytoplankton Sampling

The Zooplankton sampling was carried out by the use of a silk plankton net of 20 cm diameter and 70 meshes m attached with a 50 ml capacity bottle at the base. At each station, collection was done by sinking the net which was lowered through a distance of 1 meter.

Table 1: Mean monthly physicochemical parameters and Heavy metals samples collected from Kanye Dam (March-August, 2024).

Parameters	S1	S2	S3	S4	S5	WHO limit
Water temp. (^{0}C)	21±1.87	22±1.51	24±1.33	24±1.33	19±3.03	30ºC
Air Temp. (^{0}C)	21±1.97	23±1.94	24±3.03	24±3.03	23±2.07	
Transparency (CM)	98±21.43	85±64.40	150±1.00	150±1.00	246±61.87	5(NTU)
pH	7.1±0.63	7.1±0.67	8.1±0.19	8.1±0.19	7.4±0.60	6.5- 9.5
Alkalinity (Mg/l)	73±32.38	65±38.10	69±39.b7	69±39.b7	81±37.81	120-200
Conductivity (µs/cm)	372±92.93	385±83.43	214±170.16	214±170.16	214±211.60	300
Dissolved oxygen (mg/l)	15±4.02	12.9±5.88	10.1±6.76	10.1±6.76	9.4±1.75	4-6
BOD_5 (Mg/l)	4.3±2.61	1.2±4.87	1±4.73	1±4.73	1±1.80	10
Nitrate-nitrogen (Mg/l)	0.452±2.54	0.452±2.56	0.41±3.09	0.41±3.09	0.46±3.44	50
Phosphate-phosphorus (Mg/l)	0.09±3.19	0.1±3.40	0.21±2.42	0.21±2.42	0.3±0.01	0.5
Copper (Mg/l)	0.01±0.00	0±0.01	0±0.01	0±0.01	0±0.01	1.0
Iron (Mg/l)	0.06±0.19	0.4±0.09	0.3±0.07	0.3±0.07	0.3±0.13	0.3
Zinc (Mg/l)	1.25±0.10	1.2±0.36	1.21±0.43	1.21±0.43	1.24±0.37	5.0
Manganese (Mg/l)	0.01±0.00	0±0.01	0±0.02	0±0.02	0.01±0.24	0.1

Values represent mean± standard deviation

The samples were then poured into plastic bottles of 70 ml capacity and preserved in 4% formalin. Counting was done using the drop method and mounting the zooplankton on a microscope for identification. Identification was carried out using various keys as described by Jeje and Fernando, (1986).

Based on the physicochemical parameters studied, the temperature in the reservoir falls within the 10-50°C range established by the World Health Organization (2005) for fish and other aquatic organisms. However, only minor variations were observed between air and water temperatures. This finding aligns with Abdullahi et al. (2018), who recorded an average temperature of 25.25°C. The temperature trends during the study period reflected typical tropical patterns, with an increase from March to April followed by a gradual decline from May to August. This pattern is consistent with the observations of Ezra and Nwankwo (2001) in Gubi Reservoir, Inuwa (2007) in Jakara Dam, Adakole et al. (2008) in Kubanni Lake, Ibrahim (2009) in Challawa River, Kano State, Kefas et al. (2015) in Lake Geriyo, Adamawa State, and Nafi'u and Ibrahim (2017) in Thomas Dam, Danbatta, Kano State. Variations in electrical conductivity, pH, TDS, nitrite, and phosphate in the reservoir are typical of other lentic water bodies in northern Nigeria and fall within the permissible limits established by WHO (2005).

The concentration of nitrate-nitrogen was elevated during the rainy season, from May to

Result and Discussion

The result of the physicochemical parameters and heavy metals as well as Phytoplankton and Zooplankton analyzed is presented in the tables above.

August, likely due to runoff from agricultural areas into the dam. This runoff may result from fertilizer applications by farmers in the catchment area, as noted by Kemdirim (2000) and Musa (2009), as well as from sedimentation during the decomposition of organic matter. Low nitrate-nitrogen values typically occur during the extreme dry season, early rains, or just before the initial increase in phytoplankton growth. Kemdirim (2000) suggested that nitrate concentrations could be reduced through the uptake by plankton and macrophytes or through denitrification processes in sediments. Phosphate-phosphorus levels were found to be higher during the months of the rainy season i.e. June, July, and August compared to the months in the dry season i.e. March. April and May, attributed to runoff from adjacent farmlands where phosphate fertilizers are frequently used. The relatively higher mean values observed in certain months may be due to concentration effects resulting from reduced water volume from early March to April.

Heavy metals

The current study indicates that the aquatic life in Kanye Dam is largely unaffected by heavy metals. The concentrations of copper, iron, and manganese are within the permissible limits set by WHO (2005) for aquatic organisms, although zinc levels were slightly above the acceptable threshold. The elevated levels of dissolved substances may be linked to factors such as the characteristics of the catchment area, the components of various fertilizers, insecticides, and herbicides, as well as the presence of waste around the catchment area and groundwater leaching. These substances likely enter the lake due to runoff from extensive fertilizer use.

Table 2: Occurrence of Phytoplanktons at the five sampling sites of Kanye Dam collected from March to August 2024

TAXON	GENERA	1	2	3	4	5	Total
BACILLARIOPHYTA	*Synedra* sp.	23	16	22	31	58	92
	Tabellaria sp.	6	50	74	31	58	219
	Coscinodiscus sp.	4	53	2	-	-	59
	Diatom sp.	27	15	3	28	12	85
	Nitzchia sp.	4	5	8	19	12	48
	Palmella sp.	5	32	17	14	-	68
	Pinnularia sp.	3	5	3	6	4	21
CHLOROPHYTA	*Microcystis* sp.	16	22	12	14	16	80
	Ulothrix sp.	41	21	15	19	38	134
CYANOPHYTA	*Phacus* sp.	32	42	26	17	17	134
	Oscillatoria sp.	12	63	24	27	27	150
	Euglena sp.	54	28	35	35	37	189
Total Taxa per site		**227**	**352**	**241**	**241**	**218**	**1391**

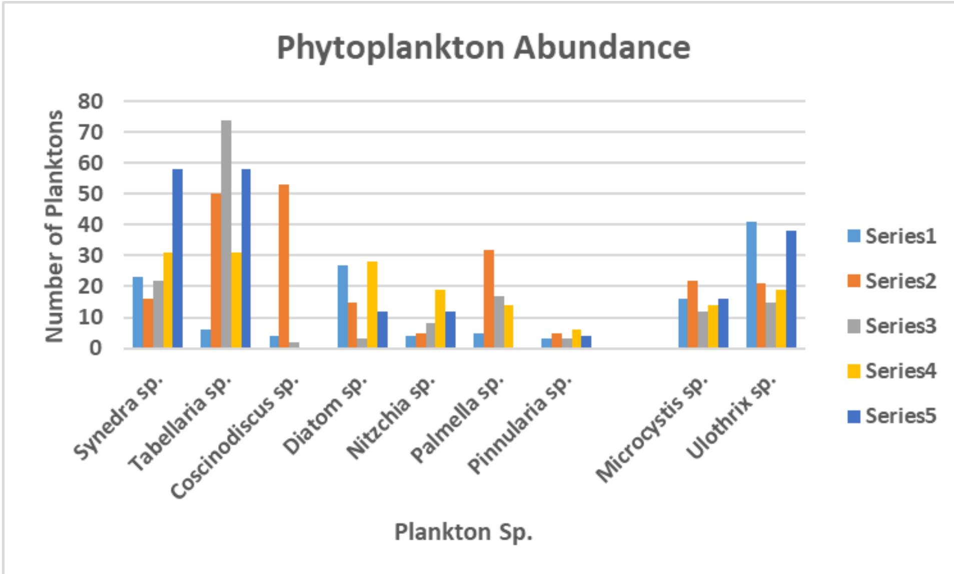

Figure 2: Occurrence of phytoplanktons at the five sampling sites of Kanye Dam collected from March to August 2024

Table 3: Occurrence of Zooplankton at the 5 sampling sites of Kanye Dam from March to August 2024**.**

TAXON	GENERAL	1	2	3	4	5	Total
PROTOZOA	*Tracheolomonas* sp.	5	5	4	7	5	26
	Plectus sp.	7	9	3	10	4	33
	Paramecium sp.	7	6	6	7	11	37
	Euglena sp.	5	6	3	24	6	44
	Amoeba sp.	11	10	24	16	15	76
	Haplotaxis sp.	4	10	3	9	11	37
	Vorticella sp.	-	12	5	4	-	31
	Anisonema sp.	-	2	1	15	15	33
ANNELIDS	*Diplogasteroides* sp.	6	3	2	4	-	15
Total Taxa per site		**45**	**60**	**49**	**92**	**67**	**332**

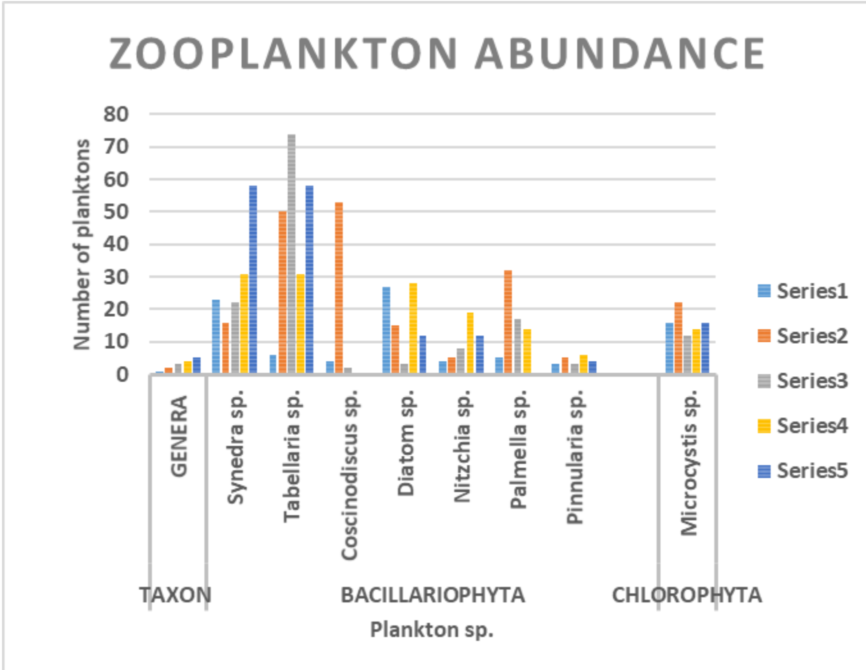

Figure 3: Occurrence of Zooplankton at the 5 sampling sites of Kanye collected Dam collected from March to August 2024.

Table 3 shows the total occurrence of zooplankton at the 5 sampling stations of Kanye Dam. A total of three hundred and thirty-two (332) species of zooplanktons belonging to one class were identified. Station 4 was found to have the highest density with a total of 92 species followed by Station 5 with 67 species followed Station 2 with 60 species followed Station 3 and 1 with 45 species. The relative percentage of various zooplanktons, with protozoa under which *amoeba sp.* was recorded with the highest percentage of 22.9 %, *Euglena sp*. of 13.3 %, *Haplotaxis* sp. with 11.2 %; *Anisonema* sp. and *Plectus* sp. each with 9.9 %, *Tracheolomanas* sp. with 8.1 % and lastly *Vorticella* sp. with 9.3 % respectively.

Phytoplankton Abundance

The phytoplanktons identified in this study were categorized into three primary groups: *Bacillariophyta, Chlorophyta*, and *Cyanophyta.* Their relative abundance varied with the seasons. These phytoplankton were present from May to October, with occasional absences. The observed abundance variations may be attributed to the availability of nitrate-nitrogen and other nutrients resulting from runoff and siltation. This finding is consistent with previous studies by Kolo (1996) and Lamai and Kolo (2003), which reported similar patterns of low diversity during certain months, attributed to turbidity in the Shiroro and Dan Zaria dams in Niger State. In contrast, other aquatic ecosystems with lower turbidity levels, as noted by Okogwu and Ugwumban (2006) and Musa (2010), exhibited different diversity trends.

Zooplankton Abundance

The zooplankton community consisted of protozoa and annelids, with the density of each group varying seasonally. Zooplankton numbers increased during the early rainy season and gradually declined as the season progressed. This pattern aligns with findings reported by Balarabe (1989) and Agwigo (1997) in their studies of ABU Farm Lake and Nnamdi Azikiwe

University stream, respectively. The highest frequency of occurrence was observed between May, likely due to the higher availability of nutrients during the rainy season compared to the dry season. This is in line with the findings of Rocha et al. (1999) that an increase in primary production (phytoplankton) tends to be followed by an increase in zooplankton number and abundance. This also corresponds with the study of Ibrahim (2008) that plankton usually reach their peak source, low predation by fish during the wet season as a result of their breeding which could also encourage a high population of zooplankton. Protozoa were found to be more prevalent than annelids, a result that contradicts the findings of Lamai and Kolo (2003) who reported that annelids were more abundant than protozoa.

Conclusion

Based on the results of this research, it can be concluded that most physicochemical parameters of Kanye Dam exhibited monthly variations. Parameters such as pH, nitrate, phosphorus, manganese, and iron were all within standard limits conducive to the survival and growth of the predominant biota in the dam. This variation reflects the seasonal inflow of water from streams, rivers, and gutters into the dam. Additionally, the distribution of both phytoplankton and zooplankton also varied across months.

References

Adakole, J.A., Abolude, D.S. and Balarabe, M.L. (2008). Assessment of Water Quality of a Man-Made Lake in Zaria, Nigeria. Proceedings of Taal: The 12th World Lake Conference: 1373-1382.

APHA (1995) American Public Health Authority. Manual of Standard Methods for Examination for Water and Waste 14th Edition. Washington Dc. p. 107.

APHA (1999) American Public Health Authority. Manual of Standard Methods for Examination for Water and Waste 14th Edition. Washington Dc. pp. 110-114.

APHA. (2005). Manual of Standard Methods for Examination for Water and Wastewater. 14th Edition. Washington Dc. pp. 121-132.

APHA. (2005). Manual of Standard Methods for Examination for Water and Wastewater. 14th Edition. Washington Dc. pp. 121-132.

Chapman, P.M. & Ronberg, G.P. (2008). Design of Monitoring Studies for Priority Pollutants. Journal of Industrial Waste, 56 (5) 200-204.

Ezra, A.G. and Nwankwo, D.I. (2001). Composition of Phytoplankton Algae in Gubi Reservoir, Bauchi, Nigeria. Journal of Aquatic Science, 16(2): 115 – 118

Hassan, K. Y., Indabawa, Kutama, A.S., Sani, I. (2013): Seasonal and Spatial Variation of the Physicochemical Parameters in Relation to Some Biological Parameters of Kanye Dam Kano, Nigeria. Int. J. Applied Res. Technol., 2(7): 31-38

Ibrahim, S. (2008). Effect of Lead on Zooplankton Dynamics in Challawa River, Kano State, Nigeria. Bayero Journal of Pure and Applied Sciences, 1(1): 88-94

Ibrahim, S. (2009). A Survey of Zooplankton Diversity of Challawa River, Kano and Evaluation of Some of its Physico-chemical Conditions. Bayero Journal of Pure and Applied Sciences, 2(1):19-26.

Jeje, C.V. and C.K. Fernando (1986). A Practical Guide To Identification Of Nigeria Zooplankton, Kainji Lake Institute, pp.89-99.

Kefas. M, Abubakar. K.A and Ali.J. (2015).The Assessment of Water Quality via Physicochemical Parameters and Macro Invertebrates in Lake Geriyo, Yola, Adamawa State, Nigeria. The

International Journal of Science & Technology, 3 (3): 284- 290

Kemdirim E.C, (2000) Diel rhythm of plankton and physicochemical parameters in Kangimi reservoir. Kaduna state Nigeria. Journal of aquatic science. 15:35-39.

Kolo R.J and Oladimeji A.A (1996). The assessment of physico-chemical parameters of Shiroro Lake and its major tributaries. Fisheries Society of Nigeria Conference proceeding. Pp 260-268.

Kolo R.J and Oladimeji A.A (2003) Water quality and some nutrients levels in Shiroro Lake: Niger state Nigeria. *Journal of Aquatic Sciences. 19 (2): pp 99-106.*

Lind, O.T. (1986) A Handbook of Limnological Methods C.V. Mosby Co. St Lovis. Pp.182-186.

Mohammed, M. A. and Saminu M.Y. (2012). Water Quality and Phytoplankton of Salanta River Kano, Nigeria. Journal of Biological Science and Bioconservation,(4):65-73.

Mu'azu, L., Yahaya, M. G., Ali, M., and Abdallah, M. S. (2021). Relative abundance and species diversity of algae in Gundutse River Kano, Northern Nigeria. International Journal of Multidisciplinary Research and Development, 8(8), 15-18.

Musa R. (2009) Some Aspect of Ecology of Kusalla Dam. Karaye, Kano Nigeria. Msc. Thesis ABU Zaria. Unpublished Pp. 1-45

Musa Y. (2010) Studies on some ecological aspects of Challawa Goje-Dam- *Msc Thesis unpublished B.U.K.* pp. *83-88*

Nafi'u, S. A., and Ibrahim, S. (2017). Seasonal dynamics of zooplankton composition and abundance in Thomas Dam Dambatta, Kano, Nigeria. Bayero Journal of Pure and Applied Sciences, 10(1), 268-276.

Okogwu T.L and Gerald S.E (2007) Handbook of Common Methods

Rocha,O.T, Matsumura-Tundisi., E.L.G. Espindola., K.F. Roche and A.C. Rietzler (1999). Ecological Theory Applied to Reservoir Zooplankton, Pp 29-51. In Tundisi, J.G and M. Straskraba (eds.). Theoretical Reservoir Ecology and its Applications. International Institute of Ecology, Brazilian Academy of Sciences. Backhuys Publishers, Leiden, Holland. pp 124

WHO, World Health Organization, International standards for drinking water, Geneva, 2005